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BEE POLLINATION OF *CUPHEA* (LYTHRACEAE) SPECIES IN GREENHOUSE AND FIELD

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Abstract.—Several species of native bees were examined as pollinators of three species of *Cuphea*, a prospective oil-seed crop, in greenhouse and field trials, and records of flower visitation by bees were assembled from literature and museum sources. The most successful pollinator in the greenhouse was the gregarious megachilid, *Osmia bruneri* Cockerell, which constructed 106 nests and produced 139 progeny using the pollen, nectar and leaves of *Cuphea leptopoda* Hemsley. Two female *Xylocopa californica* Cresson also produced progeny in the greenhouse. In the field, the only consistent visitors of *Cuphea* were three species of bumblebees (*Bombus fervidus* (Fabr.), *B. huntii* Greene and *B. occidentalis* Greene).

Key Words.—Insecta, *Cuphea, Osmia, Xylocopa, Bombus,* pollination, seed production, oil-seed crop, brood

Cuphea is a large genus of plants (260 species) with potential agricultural importance because the seeds of some species contain oils that are rich in medium-chain fatty acids (MCT). Such oils contain a high proportion of lauric acid whose main source is coconut and palm kernel, and capric acid which is derived from petrochemicals. These MCTs have important industrial applications (Hirsinger & Knowles 1984, Thompson 1984, Hirsinger 1985).

Several federal and state research units are conducting intensive breeding programs to develop *Cuphea* for commercial production. Because many of the species being studied require animal vectors to transport pollen from one plant to another, seed set is contingent upon providing effective pollinators. Although species in the genus display a wide variety of pollination syndromes, including hummingbird pollination (Feinsinger 1976), insects appear to be the most important pollinators of species with commercial promise. The honeybee, *Apis mellifera* L., however, does not visit flowers of many cross-pollinated species, even under duress (S. J. Knapp, personal communication). Thus, this study was conducted to find manageable bee species that would visit and pollinate the flowers. In addition, we assemble available bee-flower association records from various sources.

METHODS AND MATERIALS

Three species of *Cuphea* were grown from seeds. Seedlings of *Cuphea leptopoda* Hemsley were planted in a greenhouse (6 × 6 × 3 m) in February, 1986. Flowering of the 450 plants began 1 May and continued until October. In June, two flats of blooming *C. lutea* Rose in Koehne, an autogamous species, were introduced to the same room. At the same time, about 100 plants each of *C. laminuligera* Koehne and *C. lutea* were planted at Greenville Experimental Farm, North Logan,

Table 1. Species of bees released in greenhouse containing *Cuphea* plants and numbers of cells produced. Logan, Utah 1986.

Species	No. adults	Date	No. nests
Ashmeadiella aridula	19♀♀, 4♂♂	2–7 May	0
Chelostoma minutum	20♀♀, 20♂♂	20 Jun	0
Hoplitis fulgida	26♀♀, 20♂♂	24–25 Jun	0
Osmia bruneri	24♀♀, 7♂♂	27–30 May	106
Osmia sanrafaelae	21♀♀, 12♂♂	27–30 May	1+
Xylocopa arizonensis	2♀♀, 3♂♂	27 Apr	2

Utah, to provide flowers for field visitation by pollinating insects. These flowers were observed several times each week and flower visitors were recorded.

The bee species tested as potential pollinators in the greenhouse were an arbitrary selection of those obtained from trap nests placed in Utah in 1985. In addition, several adults (three males, two females) of *Xylocopa californica* Cresson were also tested. These bees were found overwintering in a dead *Yucca* flower stalk collected near St. George, Washington Co., Utah, in February. The bees and stalks were held at 3° C until late April and then set among the blooming *Cuphea* in the greenhouse.

Nesting units of several types were included for the megachilid bees. Some were wood blocks with holes drilled therein. Two sizes of soda straws (5, 8.5 mm) were alternately inserted in the holes. Other wood blocks contained 10 holes each of 5 diameters (2, 4, 6, 8, 10 mm) in Latin square design but without straw inserts. Elderberry (*Sambucus* sp.) stems with 3 mm diameter holes drilled longitudinally through the pith to a depth of 45 mm, and 3 mm holes drilled 1–2 mm into the pith perpendicular to the longitudinal axis, were also provided. Finally, several elderberry stems, each with 12 mm diameter holes drilled perpendicular to the longitudinal axis and into the pith, were included as nest sites for *X. californica.*

Results and Discussion

Greenhouse Visitation. — Five species of megachilid bees and *X. californica* were released in the greenhouse with *Cuphea.* The date and number of bees released, and the number of nests recovered, are shown in Table 1. Only *C. leptopoda* was consistently visited. The rare visits to *C. lutea* plants by *Osmia* and *Xylocopa* were of brief duration. The bees clearly preferred *C. leptopoda.* The avoidance of the flowers by half of the species is probably related to the presence of glandular trichomes on the flower (Hirsinger & Knowles 1984), which frequently entangled the mouthparts of foraging bees. Even large carpenter bees occasionally had difficulty in freeing themselves from the viscous flowers.

Of the megachilids, only the metallic-blue *Osmia bruneri* Cockerell constructed many nests and reared much brood on the pollen and nectar of *Cuphea.* Pollen and nectar were collected from about 08:30–19:00 h. These bees produced 139 cells of which 80.5% contained live adults in diapause in September. Most nests (98) and progeny (125) were produced in wood blocks in holes of 5–6 mm diameter and irrespective of whether straws were present.

Female *O. bruneri* exclusively masticated pieces of *Cuphea* leaves to line and partition their nests even though plants of other acceptable species were provided for this purpose. This leaf selection behavior is noteworthy in that *O. bruneri* has refused leaves of other crop plants such as red clover (*Trifolium pratense* L.) in other greenhouse studies (FDP, unpublished data). Thus, managing this bee for *Cuphea* pollination in greenhouse or field is simplified because it is unnecessary to provide another plant species as a leaf source.

Other attributes of *O. bruneri* make its use as a greenhouse pollinator of *Cuphea* promising. Populations of this spring bee are abundant and can be obtained by placing trap nests in mountainous locations in many western states. Its nesting behavior has been studied in the greenhouse by Frohlich (1983) whose data and that of Parker (FDP, unpublished data) show that several sizes of boring (10, 8, 6, 4 mm) are accepted for nesting. *Osmia bruneri* is univoltine and enters diapause in the adult stage in the fall. Adults can then be stored overwinter at 3° C until needed the following spring. At that time, nests with adults are incubated at 30°C for a few days to break diapause. A small percentage of overwintering adults are parsivoltine; i.e., diapause is not broken until the second spring (FDP, unpublished data).

A single nest with a few cells was produced by a female *Osmia sanrafaelae* Parker, a species whose life cycle and management requirements (Parker 1984) are similar to *O. bruneri.* The female nested in a chamber formed by the meeting of L-shaped metal joints that held the sides of the plant beds together. Other *O. sanrafaelae* were observed collecting pollen and cutting and gathering pieces of *Cuphea* leaves. These females probably also produced nests in obscure places but those nests were not found.

Both *X. californica* females lived for approximately two months and used *Cuphea* pollen and nectar to produce progeny. In contrast, adult males died about a week after their introduction to the greenhouse. Although males were seen to attempt copulation with females several times at the flowers, females produced only a few male offspring each and, thus, may have remained unmated. Foraging was limited to early morning and late evening; during the heat of the day, they remained in their nests.

Should *Cuphea* be grown commercially in the desert southwest, *X. californica* could be an important pollinator. Nests are commonly found in flower stalks of *Yucca* and *Agave* in Arizona and New Mexico. It may be feasible to collect stalks containing quiescent adults and transport them to agricultural plantings.

Field Visitation.—Only eight species of bees were recorded visiting *Cuphea* plants in the field and of these, only the three species of bumblebees (*Bombus* sp.) were numerous. The following species were collected from *C. laminuligera*: *B. fervidus* (Fabr.), *B. huntii* Greene, and *B. occidentalis* Greene. Three specimens of *Dialictus* sp., one *Agapostemon texanus* Cresson and one *Megachile rotundata* (Fabr.) were also taken from this same species. A few specimens of *Anthophora urbana* Cresson and *Calliopsis coloradensis* Cresson were collected from *C. lutea.* Both species produced abundant seed. *Cuphea lutea,* however, is known to be autofertile (Hirsinger & Knowles 1984).

Collection Records.—The most intriguing information is from S. J. Knapp (personal communication) who collected 6 bees from *C. laminuligera* in Mexico. All specimens but one *Bombus sonorus* Say were *Loxoptilus longifellator* LaBerge

(Anthophoridae). This is the first flower association for *Loxoptilus,* a genus characterized by peculiar pads of curved hairs on the galea. Perhaps these hair pads enable *Loxoptilus* females to more effectively negotiate the viscous trichomes of *Cuphea* flowers.

We (FDP) recently (July 1987) collected four species of bees foraging on an unknown species of *Cuphea* in the state of Chiapas, Mexico. Females of two new species [*Anthidium* and *Dianthidium* (*Mecanthidium*)] were collecting pollen, but the others (*Bombus mexicanus* Cresson and *Anthidium maculifrons* Smith) were collecting only nectar. L. A. Stange collected both sexes of an undescribed megachilid, *Hypanthidioides* (*Moureanthidium*), from flowers of *Cuphea* in Argentina. Hurd (1979) listed *Augochloropsis metallica metallica* (Fabr.) and *Melissodes tepaneca* Cresson visiting *C. balsamona* and *Melissodes bimaculata bimaculata* (Lep.) from *C. petiolata.* Whether any of these bee-flower records represent associations that are more than fortuitous remains to be studied.

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